MASSES AND VELOCITY OF JOVIAN DUST STREAMS DETECTED BY GALILEO.
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Recent analyses of solar wind magnetic field bending of jovian dust streams, as discovered by the cosmic dust detector on the Ulysses spacecraft [1], show that stream-associated dust grains are of the order of 10^{-18} gm and travel faster than 200 km/sec [2]. We follow the procedures of [2] to analyze jovian dust streams detected by the dust detector on the Galileo spacecraft [3]. Preliminary results show that to fit the observed Galileo spacecraft rotation angles (ϕ's) at which streams are detected (especially those streams with ϕ's very far away from the line of sight, LOS, direction to Jupiter), dust grains must be similarly small and travel with similarly high velocity as for those detected with the Ulysses spacecraft. The streams that have ϕ's far away from the LOS direction to Jupiter set the strongest constraints on the size and velocity of stream particles [2].

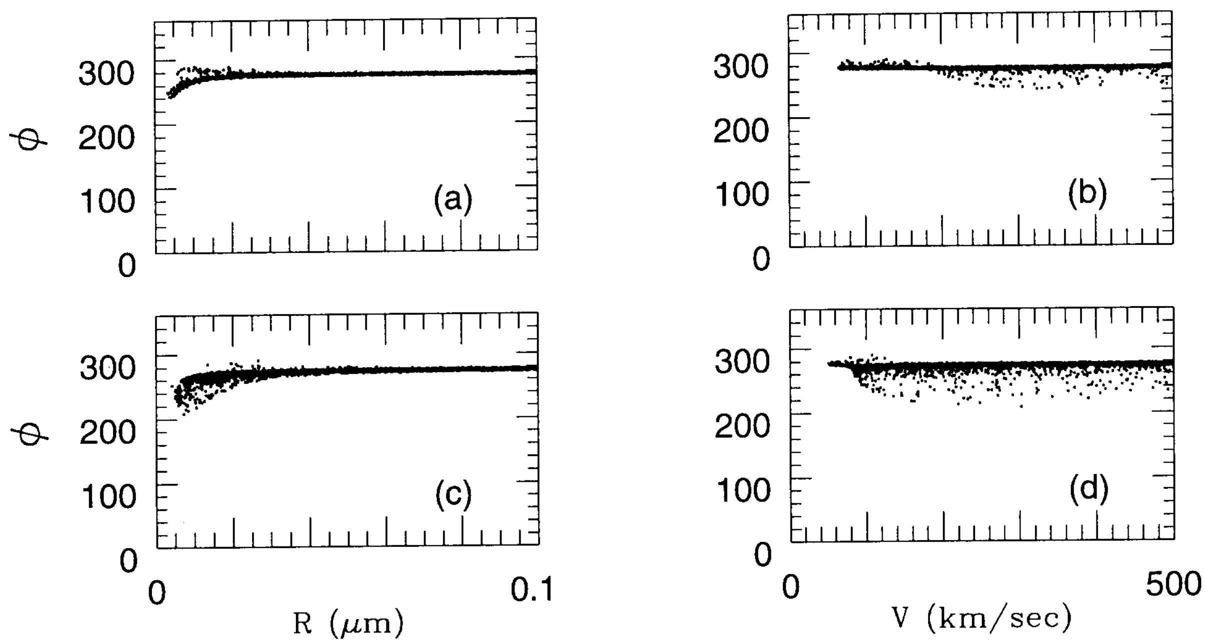
Both the Ulysses and the Galileo spacecraft detected streams of sub-micron dust particles near the vicinity of Jupiter [1,3]. Two lines of evidence suggest the jovian system as the origin of dust streams: (1) more dust particles were detected when spacecraft were closer to Jupiter, and (2) the average direction (ϕ-angle) of where particles were detected lay close to the LOS direction to Jupiter [1,2]. Detailed modeling of the motion of small charged dust particles under the gravitational forces of the Sun, Jupiter, as well as the solar wind magnetic field Lorentz force shows that jovian dust particles with radii smaller than 0.02 µm are strongly affected by the solar wind magnetic field [2].

At the mean occurrence time of each stream, in our computer modelling, 10^7 parti cles are generated with the initial conditions of the particles randomly chosen between 0 and 0.1 µm in radius, between 20 and 500 km/sec in impact velocity, between 0° and 360° in spacecraft rotation angle ϕ, and between 55° and 180° in the angle relative to the Earth-facing direction along the spacecraft spin axis. All particles are assumed to be spherical with 1 g cm^{-3} density and charged to 5 Volts. The acceleration, a, of a charged dust particle in the interplanetary space is [2]

$$a = -GM_s \frac{r_s^3}{r_s} - GM_j \frac{r_j^3}{r_j} + \frac{Q}{m}(v \times B), \qquad (1)$$

where G is the gravitational constant, M_s and M_j are the masses of the Sun and Jupiter, r_s and r_j are the position vectors of the dust particle with respect to the Sun and Jupiter, Q/m is the charge-to-mass ratio of the particle, and $v = v_p - v_{sw}$, where v_p and v_{sw} are the dust grain and solar wind velocity vectors, and B is the solar wind magnetic field vector. While B and v_{sw} are measured continuously by instruments on Ulysses, only B is measured on Galileo. However, numerical modeling on jovian dust particles detected by Ulysses shows [4] that the overall solution patterns of the dust particles do not change much whether the actual measured v_{sw} or the averaged v_{sw} are used in Eq. (1). Therefore, we have used the average solar wind velocity measured by Ulysses in our calculation of the motion of each particle detected by Galileo.

Figures (a) and (b) show the analyses for Galileo stream 1, Gl. There were 22 impacts detected over an eight day period around June 25, 1994 for this stream. Before the stream occurred, the typical impact rate for small dust particles was about one impact per 10 day period. When G 1 was detected, the spacecraft



was 1.67 AU away from Jupiter and the LOS direction to Jupiter was about 275°. The mean detected ϕ of the impacts is 223°. Figure (a) shows dust grain radius (R) versus rotation angle ϕ for the 1,718 particles (from the total of 10^7 particles simulated for this stream) that went backward in time to approach within 100 jovian radii from Jupiter. Figure (b) shows the impact velocity versus ϕ for the same particles. It is obvious that only particles smaller than 0.01 µm (4×10^{-18} g in mass) with impact velocities higher than 200 km/sec have calculated rotation angles at all close to those of the actually detected impacts.

Figures (c) and (d) show the analyses for stream G4. This is an intense dust "storm" with more than 600 impacts recorded in a 10 day period around December 30, 1994 [3]. The mean detected rotation angle of the 80 impacts that have complete information is 248° (the LOS direction to Jupiter is about 275°). Figure (c) shows radius (R) versus rotation angle ϕ for the 3,212 particles (from the total of 10^7 particles simulated for this stream) that went backward in time to approach within 100 jovian radii from Jupiter. Figure (d) shows the impact velocity versus ϕ for the same particles. Only particles smaller than 0.03 µm (1×10^{-16} g in mass) with impact velocities higher than 100 km/sec have the calculated rotation angles closer to those of the actually detected impacts.

The range in mass and velocity that we derive for the Galileo stream particles are completely consistent with those derived from Ulysses's stream analyses. The streams that had measured ϕ's further away from LOS directions to Jupiter also place more critical constraints on those ranges.

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